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ANALYSIS OF TEXTUROMETRIC PROPERTIES OF SELECTED TRADITIONAL AND COMMERCIAL SAUSAGES

Peter Zajác, Jozef Čurlej, Miroslava Barnová, Jozef Čapla

ABSTRACT

Food texture is one of the main features that affect the consumer's judgment. Instrumental texture analysis is suitable method for objective assessment of the texturometric characteristic of food. In this experimental work we have analysed textural properties of different traditional and commercial sausages originating from Slovakia. Twenty sausages were classified in four groups. Group 1 (traditional home-made sausages purchased directly from a producer), Group 2 (traditional sausages purchased from butchery), Group 3 (non-traditional sausages purchased from a supermarket) and Group 4 (non- traditional sausages purchased from a hypermarket). Once taken, samples were immediately transported to the laboratory. Samples were analysed immediately and after the storage 72 h at 25 °C and 80% relative humidity. Samples were analysed with texturometer TA-XT2 plus and we have used the Warner-Bratzler probe. The main reason of this experiment was to find differences for two selected textural parameters, firmness and toughness of the fresh and stored sausages. The average firmness and toughness of fresh sausages before storage were 1.83 kg and 12.86 $kg.s^{-1}$ respectively. These values were increased after the storage. The average firmness and toughness of stored sausages were 2.74 kg and 19.23 $kg.s^{-1}$ respectively. It means, storage affects the textural properties of sausages (p <0.05). We were observed decrease of the water activity after the storage. The loss of free water was 5.1% higher in the case of commercial sausages. Also, the protein content, fat content and minerals elements content were analysed. The content of overall protein was 5.8% higher in the traditional sausages. The fat content in commercial sausages was 3.36% higher in comparison to traditional sausages. The sensory quality of traditional sausages was better than commercial sausages.

Keywords: traditional sausage; commercial sausage; firmness, toughness; work of shear; texturometer

INTRODUCTION

There are different kinds of meat products all over the world, among which fresh sausages represent an important part **(Feiner, 2006)**. In general, meat products are made from various meat and non-meat components (from different origins and suppliers), which are combined at the formulation stage with respect to criteria of composition, technological factors, sensory characteristics, legal regulations, functionality and production cost **(Jiménez-Colmenero et al., 2010)**. The quality of meat products depends on the raw meat quality, additives, conditions of production, storage temperature and handling conditions **(Čurlej et al., 2011; Kunová et al., 2014; Kročko et al., 2014; Sedghi et al., 2014; Mati et al. 2015)**. **Kozelová et al. (2011)** investigated consumer's opinion about quality of meat and meat products. Authors found 30% of respondents highlighted the quality as lower and 19% as very low. Consumers identified in many cases as a reason for dissatisfaction textural properties. According to **Feiner (2008)** fresh sausages (and eventually the raw-semidry ones) are produced from diverse kinds of meat such as beef, pork, mutton, chicken, turkey, etc. and usually pork fat or fatty tissues. Furthermore, various non-meat ingredients (salt, herbs, spices, juices, vinegar, etc.) and additives (nitrites, phosphates, sorbates, etc.) can be added according to the type of sausage, geographical traditions or manufacturing practices. According to **(Lee, 1999)** actual making process of fresh sausages includes both traditional and non-traditional methods. Apart from flavour, smell and colour, food must have appropriate textural parameters. Texture is not only a basic objective food property but to some extent it also depends on a person that examines or consumes food. Texture is an important attribute of food quality and it extensively influences an impression from food **(Brenner, 2012)**. In food production process, there are several technological steps like mixing, pumping, kneading and many others. This process may affect the technological and final product quality **(Pollar, 2003)**. Instruments designed for texture analysis can help meat producers with quality of product **(Nollet and Toldra, 2008)**.

In this experiment we aimed at the determination of firmness and toughness of meat sausages originating from Slovakia. Main aim of this experimental study was to compare the traditional and commercial sausages in order to identify the textural differences. We were analysed fat content, protein content and minerals elements content and water activity. Also, we were analysed the changes in water activity in relation to sausages storage in regulated conditions.

MATERIAL AND METHODOLOGY

Samples

Twenty samples of sausages of different origin were divided into four groups and used for comparison of selected textural parameters. Each sample consisted with 5 pieces of sausages. Description of tested groups: Group 1 (traditional sausages purchased directly from producer), Group 2 (traditional sausages purchased from butchery), Group 3 (non-traditional sausages purchased from supermarket) and Group 4 (non-traditional sausages purchased from hypermarket).

Samples preparation

1. Samples were tempered to a room temperature (25 °C),
2. Samples were stored under controlled environmental conditions (stored for 72 h at 25 °C and 80% relative humidity).

Samples analysis

Samples were analysed:

- Immediately and
- After storage under controlled conditions.

Instruments

Determination of the selected textural parameters was performed with the TA XT2 plus texturometer (Stable Micro Systems, Surrey, UK) using the Heavy duty platform / Warner Blatzer set.

Determination of water activity a_w was performed with FA-st lab, (GBX, Lyon, France).

Determination of protein content was performed with Kjeltec 8200 (Foss, Eden Prairie MN, USA).

Determination of fat content was performed with Soxhlet Selecta DET-GRAS N (JP Selecta S.A. Barcelona, Spain).

Determination of Cu, P, Mg, Fe, K, Na, Cu and Zn was performed with AES-ICP (Agilent 5100 ICP-OES, Santa Clara USA).

Instrument setup

Setting of texturometer parameters in the Exponent software 6.1.9.1 (Stable Micro Systems, Surrey, UK) were as follows:

- load capacity 5 kg,
- texturometer arm movement before test 7 mm.s^{-1},
- probe penetration into a sample 6 mm.s^{-1},
- probe speed after measurement 10.0 mm.s^{-1},
- penetration depth of the probe into the sample 30 mm.

Measurement

Analysis of samples was performed: each sausage was sliced into 1 cm wide rings (6 rings per one piece of sausage, total number of pieces per sample was 30), which were placed into the water activity meter and water activity was measured. Consequently, rings of sample were placed into the central position of texturometer base table. Each sample was measured and the mean value was calculated for each selected textural parameters: firmness (maximum peak force in kg) and toughness (peak area - work of shear in kg.s^{-1}).

Protein content was measured according to the STN ISO 937:2001 – Kjeldahl method.

Fat content was measured according to the ČSN ISO 1443: 2002).

The Ca, P, Mg, Fe, K and Na content was measured according to the STN EN ISO 11885, 2009; STN EN 13805, 2015.

The Cu and Zn content was measured according to the STN EN 14082, 2003.

Statistical analysis

Obtained results were evaluated by the Exponent software 6.1.9.1 (Stable Micro Systems, Surrey, UK), its macro function for the obtainment of mean values, standard deviation and coefficient of variation. We used the statistical program Tanagra 1.4 (Lumière University, Lyon, France) according to **Rakotomalala (2005)**. Shapiro-Wilks test was used to test the normality of data. Statistical differences between two groups of sausages (traditional and non-traditional) and two groups of sausages (fresh and stored) in relation to firmness and toughness was evaluated with one-way MANOVA. We were testing the null hyphotesis (H_0) for main effects of factor A (traditional sausage) and factor B (non-traditional sausage) and the same for main effects of factor A (fresh sausage) and factor B (stored sausage). Furthermore, tested H_0 for interaction between variables of firmness and toughness (p <0.05). Consequently, we have used the paired Student's t-test for evaluation of differences among obtained values of individual products. Differences between samples were considered as statistically significant at p <0.05. Subsequently, the Principal Components Analysis (PCA) was performed to reducing the original data and show position of products according to the textural parameters firmness and toughness. Also, the Principal Components Analysis (PCA) was performed with the Hierarchical Clustering Procedure (HAC) to show differences between the results of paired samples of fresh and stored sausages in relation to firmness and toughness. Evaluation of the organoleptic characteristics of sausage samples was performed using the Kramer and Friedman test.

RESULTS AND DISCUSSION

In this experiment we were focused on the determination of firmness and toughness of different kind of sausages. Samples were analysed by the TA XT2 plus texturometer and Warner-Bratzler stainless-steel probe.

The PCA analysis of the products according to the firmness and toughness is presented in the Figure 1.

Statistically significant differences were found between ten samples of traditional and ten samples of commercial sausages (p <0.05) and also between commercial and traditional sausages (p <0.05) in measured texture parameters firmness and toughness (according to MANOVA test and paired t-test).

Results of water activity determination are presented in Table 1. The water activity of stored sausages was significantly (p <0.05) lower in comparison with fresh sausages. The lost of water during the storage is affecting the firmness and toughness of both, traditional and commercial sausages.

Firmness and toughness of fresh and stored sausages are shown in Table 2. The PCA analysis of the fresh and stored sausages according to the firmness and toughness is presented in the Figure 2.

When evaluating toughness in within both groups, the highest values were observed in samples of traditional sausages. Specifically, we recorded the highest average value 4.46 kg for the product no. 1. The main reason for the expected higher levels was higher percentage of meat in the analysed samples. The lowest average value was recorded in samples from a group of commercial sausages for the product no. 20 where the average toughness reached 0.69 kg. It can be concluded that the strength of untreated samples of sausages was influenced by their composition and the ratios of various kinds of meat. For soft processed meat products, made by industrial production, in which nearly always other than a relatively small portion of meat, will contain the skin, mechanically separated meat, often soya or other protein substitutes, wheat flour, potato etc. **(Pipek et al., 2002)**. The increase in the strength of meat products is specified by **Benito et al. (2005)**, who detected an increase in strength during the ripening of sausages and found that at the end of maturation, the strength parameter of the sample in comparison to control one increased two times, similar results were observed in our study. From the analyse of samples stored under modified environmental conditions in thermal chambers (72 hours at 25 °C and 80% RH) is clear, that all treated samples exhibited higher values in comparison to untreated sample. These conditions caused partial dehydration of the samples and thereby increasing their toughness. The highest average value of toughness in has sausage product no. 1 of the group of traditional sausages presented by the value 5.73 kg, generally the highest total values were recorded with traditional sausages. The lowest average value was recorded in samples from a group of commercial sausages for product no. 13 where the value was 1.02 kg. Sausages have been issued to specific conditions in order to develop a model situation that can occur in the case of incorrect storage of the product. The highest average value which determines toughness parameter had fresh product no. 1 with the value 34.89 $kg.s^{-1}$, after storage under modified terms the product no. 4 was characterized by the value 45.04 $kg.s^{-1}$. Both samples were from the group of traditional sausages. The lowest average value of toughness parameter had fresh product no. 8 presented by the value 3.91 $kg.s^{-1}$ from the group of traditional sausages, after treatment by modified conditions measured value was 8.14 $kg.s^{-1}$ for the product no. 13 from commercial sausages. The values of toughness before and after storage, varied depending on the composition of the sample.

Table 1 Water activity of fresh and stored sausages.

Product no.	**Product identification name**	**a_w Wate activity before storage**	**a_w Water activity after storage**
Product 1	Home produced sausage	0.97	0.78
Product 2	Home produced sausage	0.93	0.79
Product 3	Home produced sausage	0.92	0.76
Product 4	Home produced sausage	0.93	0.69
Product 5	Home produced sausage	0.88	0.72
Product 6	Home produced sausage	1.00	0.85
Product 7	Home sausage	0.95	0.85
Product 8	Hlohovecká sausage	0.99	0.90
Product 9	Mojmírovská sausage	1.00	0.88
Product 10	Trampská sausage	0.99	0.83
Product 11	Vysočánska sausage	0.99	0.75
Product 12	Spišská sausage	1.00	0.78
Product 13	Ipeľská sausage	1.00	0.79
Product 14	Laborecká sausage	0.98	0.78
Product 15	Tesco Gazdovská sausage	1.00	0.86
Product 16	Gazdovská sausage	0.98	0.83
Product 17	Dargovská sausage	0.99	0.79
Product 18	Prešovský kabanos	1.00	0.81
Product 19	Smoked sausage from Berto	0.99	0.78
Product 20	Zipser sausage	1.00	0.81

Note: n = 5 sausages (6 rings per one piece of sausage, total number of analysed pieces per sample was 30).

Table 2 Firmness and toughness of sausages (Part 1).

Product no.	Product group	Product identification name		Firmness before storage (kg)	Toughness before storage ($kg.s^{-1}$)	Firmness after storage (kg)	Toughness after storage ($kg.s^{-1}$)
Product 1	Group 1	Home produced sausage	Mean	4.395	36.374	5.676	36.544
			SD	0.55	3.76	0.33	6.22
			CV (%)	12.46	10.34	5.85	17.02
Product2	Group 1	Home produced sausage	Mean	2.377	14.933	3.658	19.638
			SD	0.46	2.81	1.51	6.60
			CV (%)	19.15	18.83	41.16	33.63
Product 3	Group 1	Home produced sausage	Mean	2.632	22.884	5.460	40.072
			SD	0.31	2.35	0.43	2.73
			CV (%)	11.95	10.29	7.96	6.82
Product 4	Group 1	Home produced sausage	Mean	3.049	23.954	5.378	43.188
			SD	0.31	1.78	0.48	3.84
			CV (%)	10.27	7.44	9.00	8.90
Product 5	Group 1	Home produced sausage	Mean	3.337	24.119	4.475	35.701
			SD	0.75	1.58	0.86	5.21
			CV (%)	22.44	6.54	19.18	14.58
Product 6	Group 2	Home produced sausage	Mean	3.143	20.359	2.664	19.264
			SD	0.44	2.13	0.29	2.85
			CV (%)	14.07	10.48	10.97	14.78
Product 7	Group 2	Home sausage	Mean	0.694	4.569	1.478	10.191
			SD	0.24	1.71	0.16	0.84
			CV (%)	35.20	37.50	10.62	8.24
Product 8	Group 2	Hlohovecká sausage	Mean	1.987	9.862	3.127	18.308
			SD	0.66	2.57	0.82	2.39
			CV (%)	33.27	26.04	26.17	13.05
Product 9	Group 2	Mojmírovská sausage	Mean	1.260	6.484	2.776	18.138
			SD	0.21	1.00	0.33	4.64
			CV (%)	16.66	15.49	11.73	25.58
Product 10	Group 2	Trampská sausage	Mean	0.734	5.256	1.247	8.821
			SD	0.15	0.76	0.14	1.38
			CV (%)	20.44	14.42	11.58	15.67
Product 11	Group 3	Vysočánska sausage	Mean	0.887	7.130	1.272	11.295
			SD	0.08	0.78	0.28	1.84
			CV (%)	9.41	10.97	21.81	16.25
Product 12	Group 3	Spišská sausage	Mean	0.991	8.102	1.537	13.620
			SD	0.12	1.23	0.32	3.72
			CV (%)	12.37	15.15	21.06	27.30

Table 2 Firmness and toughness of sausages (Part 2).

Product no.	Product category	Product identification name		Firmness before storage (kg)	Toughness before storage (kg.s^{-1})	Firmness after storage (kg)	Toughness after storage (kg.s^{-1})
Product 13	Group 3	Ipeľská sausage	Mean	0.995	8.059	1.584	10.529
			SD	0.13	0.78	0.37	1.34
			CV (%)	13.21	9.62	23.08	12.71
Product 14	Group 3	Laborecká sausage	Mean	0.710	5.354	1.401	9.607
			SD	0.12	1.02	0.42	2.17
			CV (%)	17.34	18.98	30.28	22.55
Product 15	Group 3	Tesco Gazdovská sausage	Mean	1.669	12.210	2.667	17.033
			SD	0.16	0.82	0.54	1.58
			CV (%)	9.74	6.70	20.44	9.29
Product 16	Group 4	Gazdovská sausage	Mean	2.798	17.565	3.175	18.322
			SD	0.43	2.14	1.00	5.06
			CV (%)	15.44	12.20	31.56	27.60
Product 17	Group 4	Dargovská sausage	Mean	0.760	6.875	0.983	8.396
			SD	0.10	1.06	0.13	1.17
			CV (%)	13.38	15.38	13.71	13.97
Product 18	Group 4	Prešovský kabanos	Mean	0.898	7.664	1.202	10.496
			SD	0.20	0.91	0.22	2.30
			CV (%)	22.50	11.84	18.05	21.94
Product 19	Group 4	Smoked sausage from Berto	Mean	1.101	7.849	1.770	16.330
			SD	0.23	1.14	0.52	4.80
			CV (%)	21.34	14.50	29.37	29.38
Product 20	Group 4	Zipser sausage	Mean	2.231	7.584	3.228	19.176
			SD	0.74	0.79	0.75	2.81
			CV (%)	33.14	10.47	23.38	14.63

Note: n = 5 sausages (6 rings per one piece of sausage, total number of analysed pieces per sample was 30).

It can be assumed that the value of the toughness can be affected by natural packaging materials used for various sausages. Assignment of water activity (a_w) of each sample was used in order to verify the objectivity of the results obtained by measuring the texture. Water activity was assessed by use of the apparatus FA-st lab. The suitability of measurement of water activity was clearly demonstrated by **Mati et al. (2014)**, who assessed the water activity of dried meat purchased in a commercial network and from the manufacturer immediately after opening during the 24 hrs., 48 hrs., 96 hrs., 168 hrs., during storage in a dark room for 168 hrs. and after storage at a hermetically sealed package in the same time period.

In our study, we assessed the water activity of commercial and traditional sausages at room temperature. Under the same conditions, assessment of water activity realized for commercial and industrially produced sausages points to a higher free water loss in comparison to traditionally produced sausages.

The percentage decline was in commercial products purchased in the supermarket as follows: product no. 11 → 25%, no. 12 → 22%, n. 13 → 21%, no. 14 → 21%, no. 15 → 14%. For commercial products bought in hypermarket: no. 18 → 20%, no. 20 → 19%, no. 19 → 21%, no. 17 → 20%, no. 16 → 15%. Traditional sausages directly from the producer: product no.1 → 16%, no. 2 → 15%, no. 3 → 18%, no. 4 →16%, no. 5 → 19%. For products of traditional sausages purchased from the butcher: product no. 6 → 15%, no. 7 → 11%, no. 8 → 10%, n. 9 → 13%, no. 10 → 16%.

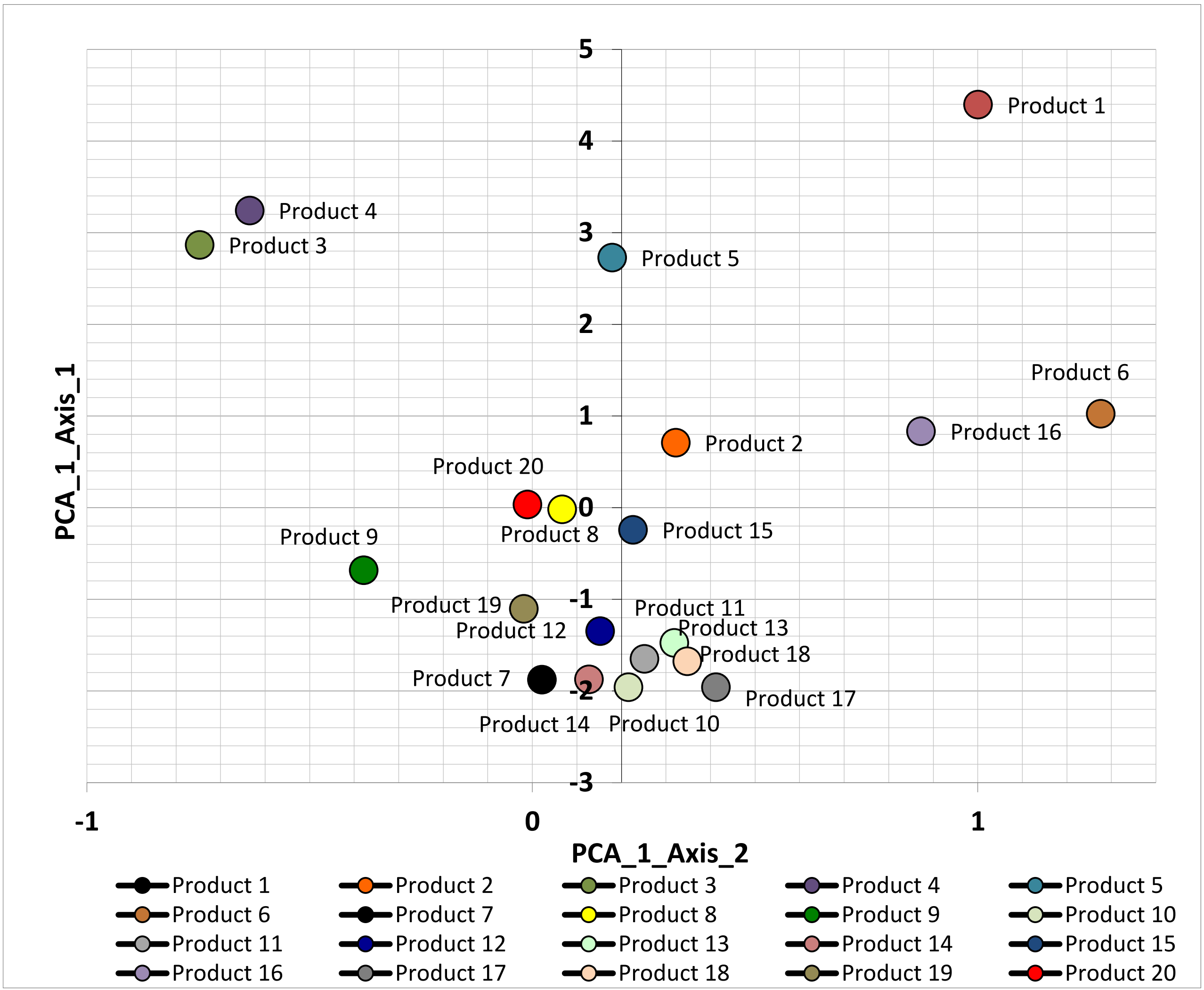

Figure 1 PCA analysis of the products according to the firmness and toughness (PCA_1_Axis_1 and PCA_1_Axis_2 represents the data of firmness and toughness before and after storage).

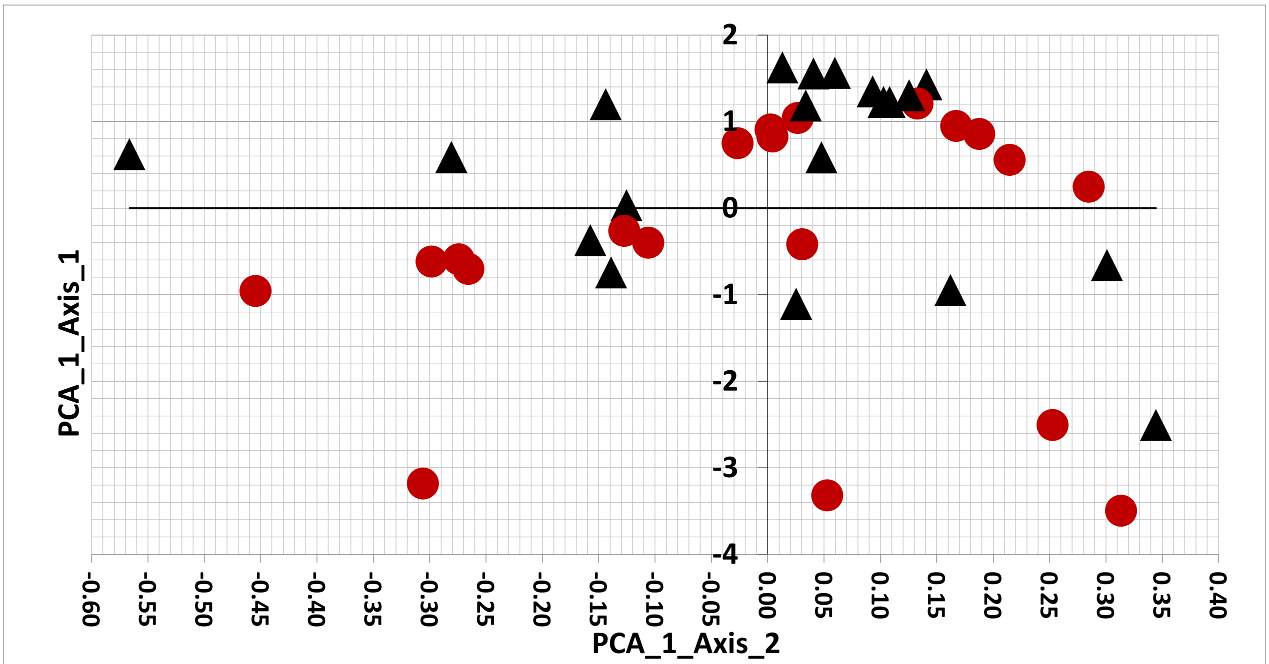

Figure 2 PCA analysis of the fresh (▲) and stored (●) sausages (PCA_1_Axis_1 and PCA_1_Axis_2 represents the data firmness and toughness).

Table 3 The composition of sausages.

Product	Ca ($mg.kg^{-1}$)	Fe ($mg.kg^{-1}$)	P ($mg.kg^{-1}$)	K ($mg.kg^{-1}$)	Mg ($mg.kg^{-1}$)	Na ($mg.kg^{-1}$)	Zn ($mg.kg^{-1}$)	Total protein content (%)	Total fat content after hydrolysis (%)
Product 1	132	13.9	2580	4700	221	11160	36.3	29.19	26.30
Product 2	165	11.2	2610	4690	219	11390	38.0	26.30	27.51
Product 3	136	9.7	3030	5400	269	9290	41.6	32.19	23.97
Product 4	160	6.7	2110	3970	203	10550	32.3	24.36	41.22
Product 5	158	10.1	2190	4520	233	10510	22.6	22.55	32.02
Product 6	192	6.4	2340	3100	174	8470	17.2	16.74	22.55
Product 7	212	6.6	2200	3480	193	10020	21.8	17.69	29.66
Product 8	147	11.3	1920	3370	214	9110	27.3	18.07	28.45
Product 9	189	8.5	2420	3030	186	9490	26.4	16.82	21.50
Product 10	207	6.3	2480	2680	163	8220	18.4	14.60	30.33
Product 11	173	3.2	2130	2330	130	9150	17.5	14.72	31.99
Product 12	205	4.6	1840	1800	126	8650	10.7	0.77	31.49
Product 13	149	3.9	1920	3460	188	9800	19.2	19.06	30.49
Product 14	202	6.1	1360	1630	101	8820	11.4	11.94	33.59
Product 15	138	8.4	2020	3380	209	10110	17.0	18.41	31.88
Product 16	264	6.4	2010	1790	109	10030	10.5	11.90	18.12
Product 17	169	6.4	1620	2510	155	8180	15.3	15.30	28.48
Product 18	273	6.2	2090	993	125	10690	11.3	13.08	18.62
Product 19	152	5.1	2180	1330	145	8270	17.6	16.19	30.26
Product 20	430	11.4	2160	1180	145	9450	13.3	14.01	29.12

Note: n = 6

According to **Mati et al. (2014)** samples of commercially produced sausages and purchased in outlets are more stable in comparison with traditional sausages. In contrast, we found the commercially purchased samples of sausages had significantly greater decrease in free water in comparison with traditional sausages.

According to this we can conclude that during the production of sausages are used in small proportion other meat and additives of non-meat origin which ultimately may extend the shelf life of the product but on the other hand may adversely affect the nutritional value of the final product, compared with traditionally-made sausages.

Water activity can vary widely respectively it may be affected by the presence of various soluble substances and their level, such as sugar and salt **(USDA-FSIS 2007)**.

The use of different ways for the production of sausages may significantly affect the nutritional composition of the final product. In order to prevent negative impacts on customers, these changes are regulated in many countries by the legislation. For example, in most countries maximum fat content and minimal proportion of lean meat is established. Furthermore, it is generally required minimum content of proteins, but they may be derived from meat or cheaper sources such as wheat gluten and soy protein **(Freiner, 2008)**. In our study it was not possible, to rely on the legal requirements during the analysis of the product due to the fact that the sausages are classified as other meat products for which there are no specified limits of protein and fat. This is also one of the findings of the project confirming observations of the practice that such legislation is not a sufficient protective tool that may control and block the trend of decreasing quality of Slovak soft meat products and is not an effective tool to control it. As **Pipek (1999)** shown in his paper focused to analytics of the meat content of meat products, should always be based on the fact that meat is presented as a muscle consist of approximately 20% protein content, about 70% water content with varying fat content and about 1 – 2% content of extractive substances and minerals. If is during the production of meat characterized by these properties incorporated only technologically requirement water amount (about 10 – 20%) can be expected in meat products 10 – 20% protein content. Collagen and other proteins as a pure meat protein are not considered, so the final value of protein is in that case affected by about 1%. This finding demonstrated the results of the work where the observed variability within each group of sausages (assessed by standard deviation) was high. This could be attributed mainly to variations in the amount of fats used in the production process of sausages and their degree of drying. Commercial sausages bought at the supermarket reporting higher percentages of fat compared to sausages produced in the traditional way. The commercially purchased sausage exhibited 28.68% average fat content. For traditional sausages an average value was 25.32% for the fat content. On the basis of these findings we can conclude that commercial sausages reached higher fat content (about plus 3.4% more) in comparison to traditional ones. When evaluating the total protein for commercial sausages, the average value reached the level of 14.60%, for traditional sausages it was 20.40%. The proportion of total protein in traditional sausages was increased by 5.8% value. Results coming from comparison of the mineral content, expressed in $mg.kg^{-1}$ based on the total weight of fresh samples shown significant differences between traditional and commercial sausage. As **González-Tenorio et al. (2012)** reported in their study, these differences could be attributed to different ingredients, additives and also dryness of sausage samples. Comparing the results with the above mentioned study carried out by **González-Tenorio et al., (2012)**, who were focused to comparing the content of fat, protein and minerals between home-made and commercial sausages marked as Chorizo from Mexico, similarly than in our study they reached higher level of protein and lower level of fat in traditional sausages and higher values of the fat and lower protein levels in commercial sausage. On the base of these findings they concluded that a higher proportion of the protein in traditional type sausage is related to higher proportion of lean meat in comparison to non-traditional sausages. Lean meat is the main ingredient in the composition of the sausages and it has relatively high protein content, about 65% of dry matter **(USDA, 2010)**.

In terms of nutritional value minerals are essential nutrients and our results provides useful information on what customers consume. The content of minerals (Ca, Fe, P, K, Mg, Na, Zn) in sausages is presented in Table 3. We have found different concentration of mineral elements between both categories of sausages. The content of minerals in traditional sausages was: Na 9821 $mg.kg^{-1}$, K 3894 $mg.kg^{-1}$, P 2388 $mg.kg^{-1}$, Ca 169.8 $mg.kg^{-1}$, Fe 9.07 $mg.kg^{-1}$, Zn 28.19 $mg.kg^{-1}$, Mg 143.3 $mg.kg^{-1}$. The content of minerals in commercial sausages was: Na 9315 $mg.kg^{-1}$, K 2040.3 $mg.kg^{-1}$, P 1933 $mg.kg^{-1}$, Ca 215.5 $mg.kg^{-1}$, Fe 6.17 $mg.kg^{-1}$, Zn 14.38 $mg.kg^{-1}$, Mg 207.5 $mg.kg^{-1}$.

Traditional sausages contained higher amounts of iron and zinc. In the consumption of meat brings these mineral micronutrients health benefits most significantly **(McAfee et al., 2010)**. Higher values of zinc and iron in traditional sausage rather than in non-traditional ones could be explained by the use of higher proportion of lean meat originated from older animals (with higher iron content). **González – Tenorio et al., (2012)** reported high levels of iron in sausages from rural markets. This finding does not only relate to the age of the animals, but also with the possibility of iron ions migration to meat and sausage mixtures from surfaces of cast iron tools, that means from dishes, grinders **(Quitaes et al., 2004)**, which are commonly used in domestic production. Despite the small amount of iron in non-traditional sausage was its concentration in sausages purchased from urban wholesale markets comparable to traditional ones. This may be an indicator of the application of mechanically separated meat containing higher amounts of iron, about two-times higher iron content than handmade deboned meat. The differences between both groups of sausages regarding the content of sodium may be explained by typically used higher amounts of salt under the non-traditional production processes. Similarly, higher sodium content in the traditional type of sausages was also reported by **González-Tenorio et al., (2012)**. A similar trend was observed at concentrations of phosphor. Physiological phosphor is a component of protein structures in animal tissues and its concentration in meat products can be estimated from the protein concentration, this could be the reason of higher values of this substance in traditional sausages. **González-Tenorio et al., (2012)** reported higher phosphor concentration in non-traditional sausages what can be caused by controlled addition of phosphates and soya granulate (non-meat protein ingredients with high phosphor content) commonly used under commercial sausage production. To notice, the maximum phosphates content regulated by the EU is set to 5 $g.kg^{-1}$ (expressed as P_2O_5) in respect to soya granules is the ratio to the protein content higher than those in meat. Calcium concentrations were higher in non-traditional sausages (made for the lowest possible costs). As reported by **González – Tenorio et al., (2012)** elevated concentrations may be associated with the use of mechanically separated meat (mechanically separated meat from the bones) and soy granules. Mechanically separated meat is cheaper than conventional meat and in sausage production is used to reduce the costs. It has higher calcium content than meat deboned by hands, 40 – 500 mg depending on the raw material and used devices **(Newman, 1981; USDA, 2010)**. Higher values of potassium in traditional sausages could be due to different feeding of pigs, as it was confirmed by the study of **González – Tenorio et al., (2012)**, as well as authors we also confirmed lower levels of magnesium in traditional sausages, probably due the use of pure muscle without the use of mechanically separated meat. In our study evaluating the organoleptic characteristics of sausage samples using Kramer and Friedman test did not found statistically significant differences between the versions at significance level $\alpha = 0.05$. On the base of the results we can conclude, that different samples are similar from the quality determination. During the first and second measurement of sausages best fits the groups B and C. Group A has lost more points in spot test, compared to other ones. During the first and second measurement of sausages we did not revealed statistically significant differences by the use of non-parametric tests such as Kramer and Friedman test. In Kramer test interval calculated amount is completely covered by tabular interval. As reported **Zajác et al. (2013)**, the main objective of food safety policy of the European Union is to achieve the highest possible level of human health protection and consumers' interests in this field. Therefore, is focused on food safety and appropriate labelling, taking into account the diversity of traditional products while trying to ensure the efficient functioning of the market.

Each handling of food from the producer to the final consumer must be conducted in a hygienic manner to protect the quality and safety.

CONCLUSION

Texture is one of the most important sensory properties of sausages. Consumer rejects product even if it is safe, unless it has got desirable sensory attributes. Assessment of textural properties gives space for their optimization. Obtained knowledge from the texture assessment of traditional and commercial sausages can be useful for producers. Due to the continuous increase in consumers` requirements for food quality, they can more effectively improve the textural properties quality of their products in comparison with traditional homemade sausages. The average firmness and toughness of fresh sausages before storage were 1.83 kg and 12.86 $kg.s^{-1}$ respectively. These values were increased after the storage. The average firmness and toughness of stored sausages were 2.74 kg and 19.23 $kg.s^{-1}$ respectively. It means, storage affects the textural properties of sausages (p <0,05). The loss of free water was 5.1 % higher in the case of commercial sausages. The protein content, fat content and minerals elements content was analysed. The content of overall protein was 5.8 % higher in the traditional sausages. The fat content in commercial sausages was 3.36 % higher in comparison to traditional sausages. The sensory quality of traditional sausages was better than commercial sausages. The content of minerals in traditional sausages was: Na 9821 $mg.kg^{-1}$, K 3894 $mg.kg^{-1}$, P 2388 $mg.kg^{-1}$, Ca 169.8 $mg.kg^{-1}$, Fe 9.07 $mg.kg^{-1}$, Zn 28.19 $mg.kg^{-1}$, Mg 143.3 $mg.kg^{-1}$. The content of minerals in commercial sausages was: Na 9315 $mg.kg^{-1}$, K 2040.3 $mg.kg^{-1}$, P 1933 $mg.kg^{-1}$, Ca 215.5 $mg.kg^{-1}$, Fe 6.17 $mg.kg^{-1}$, Zn 14.38 $mg.kg^{-1}$, Mg 207.5 $mg.kg^{-1}$.

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Contact address:

Ing. Peter Zajác, PhD., Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, E-mail: peter.zajac@uniag.sk.

Ing. Jozef Čurlej, PhD., Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, E-mail: jozef.curlej@uniag.sk.

Ing. Miroslava Barnová, Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, E-mail: miroslava.barnova@uniag.sk.

Ing. Jozef Čapla, PhD., Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, E-mail: jozef.capla@uniag.sk.